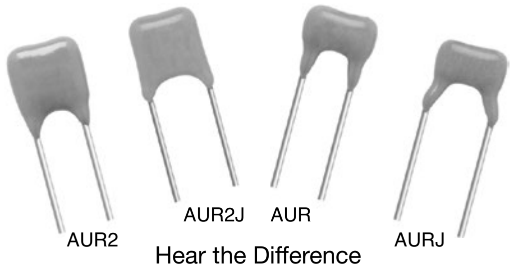
Ultra High-Precision Through-Hole Bulk Metal® Z-Foil Technology, Low Profile Conformally Coated for Audio Applications with TCR Down to 0.05 ppm/°C, Low Harmonic Distortion, and Noise Stabilization

FEATURES

- Temperature coefficient of resistance (TCR):
  ±0.05 ppm/°C nominal (0°C to +60°C)
  ±0.2 ppm/°C nominal (–55°C to +125°C, +25°C ref.)
  (see Table 1)
- Tolerance: to ±0.01%
- Power rating: to 300 mW at +70°C
- Load life stability: to ±0.01% at 70°C, 2000 h at rated power
- Resistance range: 5 Ω to 120 kΩ
- Vishay Foil resistors are not restricted to standard values; specific "as required" values can be supplied at no extra cost or delivery (e.g., 1K2345 vs. 1K)
- Significantly lower microphonics than any other resistor technology
- Thermal stabilization time: <1 s (within 10 ppm of steady state value)
- Electrostatic discharge (ESD): up to 25 kV
- Maximum working voltage: 300 V
- Non-inductive, non-capacitive design
- Rise time: 1 ns effectively no ringing
- Current noise of 0.010 μV_{rms}/V of applied voltage (<–40 dB)
- Voltage coefficient <0.1 ppm/V
- Non-inductive: <0.08 µH
- Non hot spot design
- Terminal finish: lead (Pb)-free or tin/lead alloy
- Matched sets are available per request



Hear the Difference

Pb-free Available

RoHS* COMPLIANT

RELATED FACTS AT A GLANCE

Please refer to FACTS #106, Selecting Resistors for Pre-Amp, Amplifier, and Other High-End Audio Applications.

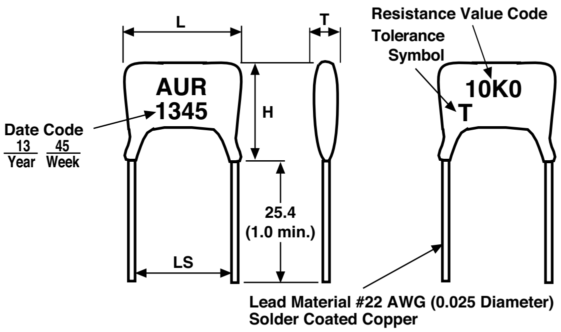
INTRODUCTION

Many manufacturers and users of precision electronic equipment suffer needlessly from unexplained instabilities and drifts due to noise effects and harmonic distortion. They resign themselves to making constant adjustments and troubleshooting. But in fact these can be avoided. Instability is often traceable to a few supposedly "fixed" resistors which are not really fixed at all. If these resistors would only retain their original values, there would be no need for costly controls and other compensating circuitry. That's why the only resistor for applications such as these is Z Bulk Metal® Foil. In high-end audio equipment, careful selection of resistors is one of the best ways to avoid or minimize noise and distortion in the signal path. Noise is an unwanted wide spectrum signal that may be superimposed on any useful signal, including DC. Resistors, like other passive components, are noise sources to various degrees, depending upon resistance value, temperature, applied voltage, and resistor type. Many experiments have been done to show why some resistors are "noisier" than others. But the only test that audio experts and audiophiles have agreed on is comparing the level of fidelity that results when different resistor technologies are used in actual audio systems.

High-end analog audio applications require low intrinsic noise, high linearity of amplification, and minimal dynamic distortion. The typical audio amplifier consists of a voltage preamplifier (preamp) and power amplifier (final driver). The voltage preamplifier deals with low-level signals. That is why its intrinsic noise level is critical. Resistors are among the principal noise sources in the amplifiers. The main requirements for the audio power amplifier are high linearity of amplification and minimal dynamic distortion. Vishay Foil resistors are characterized by very low intrinsic non-linearity of the resistive element, which is made from cold-rolled bulk metal.

The AUR, composed of VFR's Bulk Metal® Z-foil technology, with improved sound quality, provides a combination of low noise and low inductance/capacitance, making it unrivalled for applications requiring low noise and distortion-free properties.

FIGURE 1—STANDARD IMPRINTING AND DIMENSIONS in Millimeters (Inches)



Type	L	H	T	LS
AUR	5.8 ±0.5 (0.228 ±0.02)	5.5 ±1 (0.216 ±0.04)	2.2 ±0.5 (0.086 ±0.02)	3.81 ±0.25 (0.150 ±0.01)
AURJ				5.08 ±0.25 (0.200 ±0.01)
AUR2	6.7 ±0.5 (0.263 ±0.02)	8 ±1 (0.315 ±0.04)	2.78 ±0.5 (0.110 ±0.02)	3.81 ±0.25 (0.150 ±0.01)
AUR2J				5.08 ±0.25 (0.200 ±0.01)

Note

Letter J indicates a difference in lead spacing and -2 is an extension range.

TABLE 1—TOLERANCE AND TCR VS. RESISTANCE VALUE

(–55°C to +125°C, +25°C Ref.)

Resistor	Resistance Value (Ω)	Typical TCR and Max. Spread (ppm/°C)	Tolerance (%)
AUR2, AUR2J	60k to 120k	±0.2 ±1.8	±0.02%
AUR, AURJ	50 to <60k	±0.2 ±1.8	±0.01%
	20 to <50	±0.2 ±2.8	±0.02%
	10 to <20	±0.2 ±4.8	±0.02%
	5 to <10	±0.2 ±6.8	±0.05%

FIGURE 2—POWER DERATING CURVE

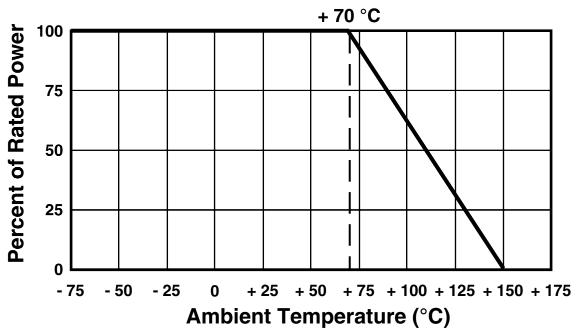
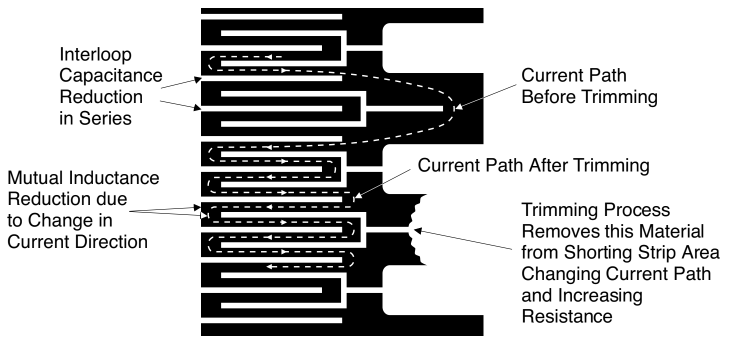


TABLE 2—PERFORMANCE SPECIFICATIONS

Test	Conditions	ΔR (%), Typical	ΔR (%), Maximum
Moisture Resistance	MIL-STD-202, method 106	±0.005	±0.03
Pressure Cooker Test	2 atmospheres absolute pressure, 121°C, 100% R.H. for 100 h	±0.2	±0.4
Short Time Overload	6.25 x P_{nom}, 5 s	±0.005	±0.05
Resistance to Solder Heat	+260°C, 20 s	±0.01	±0.03
Terminal Strength	2 lbs, 10 s	±0.0025	±0.03
Insulation Resistance	DC 100 V, 2 min	>10 000M	>10 000M
Dielectric Withstanding Voltage	AC 300 V, 1 min	±0.0025	±0.03
Thermal Shock	–65°C to +150°C, 5 cycles	±0.01	±0.02
Shock	MIL-STD-202, method 213, condition I	±0.005	±0.03
Vibration	MIL-STD-202, method 204, condition D	±0.01	±0.03
Load Life Stability	0.3 W, +70°C, 2000 h	±0.01	0.015
Thermal EMF	—	0.07 μV/°C	0.1 μV/°C
Current Noise	Quan-Tech	–40 dB	–40 dB
Low Temperature Storage	24 h at –65°C	±0.005	±0.01
Low Temperature Operation	45 min at –65°C	±0.005	±0.01
High Temperature Exposure	+150°C	±0.01	±0.03

FIGURE 3—TRIMMING TO VALUES (conceptual illustration)



Foil shown in black, etched spaces in white

Note
To acquire a precision resistance value, the Bulk Metal® Foil chip is trimmed by selectively removing built-in "shorting bars." To increase the resistance in known increments, marked areas are cut, producing progressively smaller increases in resistance. This method reduces the effect of "hot spots" and improves the long-term stability of the Vishay Foil resistors.

POST MANUFACTURING OPERATIONS (PMO)

Many audio analog applications can include requirements for performance under conditions of stress beyond the normal and over extended periods of time. This calls for more than just selecting a standard device and applying it to a circuit. The standard device may turn out to be all that is needed but an analysis of the projected service conditions should be made and it may well dictate a routine of stabilization known as post manufacturing operations or PMO. The PMO operations that will be discussed are only applicable to Bulk Metal Foil resistors. They stabilize Bulk Metal Foil resistors while they are harmful to other types. Short time overload, accelerated load life, and temperature cycling are the three PMO exercises that do the most to remove the anomalies down the road. VFR Bulk Metal Foil resistors are inherently stable as manufactured. These PMO exercises are only of value on Bulk Metal Foil resistors and they improve the performance by small but significant amounts. Users are encouraged to contact Vishay Foil Resistors' applications engineering for assistance in choosing the PMO operations that are right for their application.

SEVERAL TYPES OF NOISE FOUND IN RESISTORS

Thermal noise is caused by thermal movement of electrons in resistive material and gets worse as resistance and temperature increase. Thermal noise can be reduced by reducing resistance, temperature, or signal bandwidth.

Shot or fluctuation noise is caused by the discrete nature of charge carriers and fluctuation of their number in the unit of volume. Shot noise can be reduced by reducing bandwidth or increasing current. The spectral density of voltage in both thermal and shot noises is uniformly distributed in entire range of frequencies ("white" noise). The level of these types of noise does not depend on resistor type (resistive element material).

Current (excess, flicker) noise has 1/f type spectral density of voltage ("pink" noise). Its level essentially depends on resistor material. Current noise can be reduced by (a) avoiding use of the low frequency band, (b) reducing current, (c) increasing the volume of resistive material, i.e. by using resistors with higher rated power than is needed for proper power dissipation, or (d) using less noisy resistive materials.

Carbon composition resistors are the noisiest such device type followed by Thick Film and Thin Film resistors. The least noisy are bulk metals and metal alloys (foil, wire). At that, negligible capacitance/inductance of foil resistors (when compared to wirewound resistors) significantly reduces probability of self-excitation or "ringing" of amplification circuit.This is why Bulk Metal® foil resistors are such a good choice for low-noise applications.

TABLE 4—GLOBAL PART NUMBER INFORMATION(1)

NEW GLOBAL PART NUMBER: Y470012K7560T9L (preferred part number format)

Y	4	7	0	0	1	2	K	7	5	6	0	T	9	L

DENOTES PRECISION
- **Y**

VALUE
- **R** = Ω
- **K** = kΩ

CHARACTERISTICS
- **0** = standard
- **9** = lead (Pb)-free
- **1 to 999** = custom

PRODUCT CODE
- **4700 =** AUR
- **4701 =** AURJ
- **4702 =** AUR2
- **4703 =** AUR2J

RESISTANCE TOLERANCE
- **T** = ±0.01%
- **Q** = ±0.02%
- **A** = ±0.05%
- **B** = ±0.10%
- **C** = ±0.25%
- **D** = ±0.5%
- **F** = ±1.0%

PACKAGING
- **L** = bulk

FOR EXAMPLE: ABOVE GLOBAL ORDER Y4700 12K7560 T 9 B:

TYPE: AUR
VALUES: 12.7560 kΩ
ABSOLUTE TOLERANCE: 0.01 %
TERMINATION: lead (Pb)-free
PACKAGING: bulk

HISTORICAL PART NUMBER: AUR T 12K756 T B (will continue to be used)

AUR	**T**	**12K756**	**T**	**B**
MODEL	TERMINATION	RESISTANCE VALUE	TOLERANCE	PACKAGING
AUR **AURJ** **AUR2** **AUR2J**	**T** = lead (Pb)-free None = tin/lead alloy	12.756 kΩ	**T** = ±0.01% **Q** = ±0.02% **A** = ±0.05% **B** = ±0.10% **C** = ±0.25% **D** = ±0.5% **F** = ±1.0%	**B** = bulk

Note
(1) For non-standard requests, please contact Application Engineering

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